

# Levee Closure Systems

Best Practices in Dam and Levee Safety Risk Analysis

Part H – Operational Risks

Chapter H-5

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US Army Corps  
of Engineers®



# Outline:

## Levee Closure Systems (H-6)

- Purpose of levee closure systems
- Primarily an operational risk as opposed to structural, etc.
- Types of levee closure systems
- Risk factors to consider for different types of levee closure systems
- Example event tree
- Key takeaways





# Purpose of Levee Closure Systems

- Closure systems are usually temporary structures that serve as a damming surface during periods of flooding
- During periods of non-flooding, closures are removed to provide access through the line of protection
- Most common types are associated with vehicles, rails, and culverts
- Many times there are several different types of closures utilized for a levee segment depending upon the number of access points required.
- Each type has their own risk factors

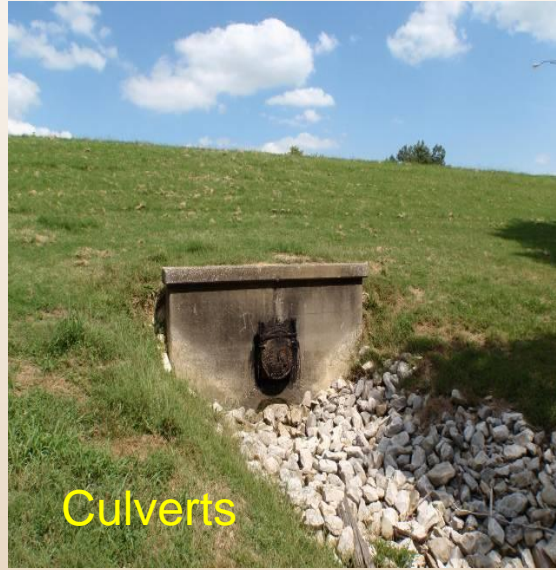




# Types of Levee Closure Systems



Moveable Gates



Culverts



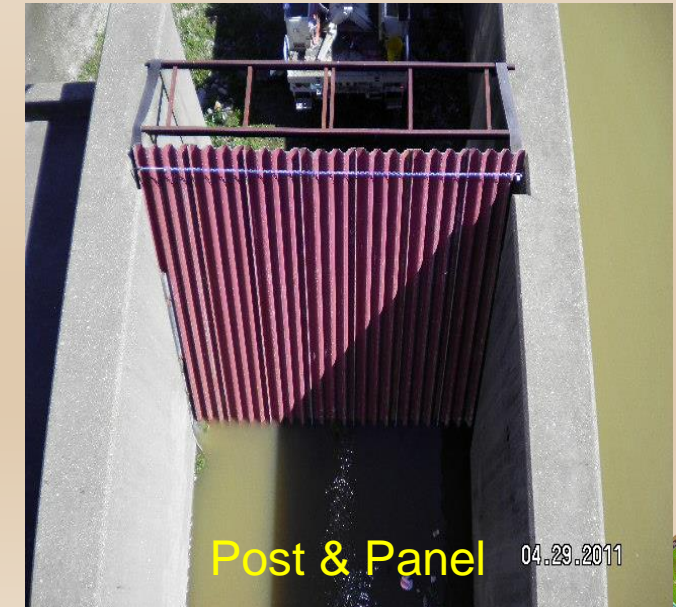
Sand Bags



Stoplogs



Soil Pile/Soil Baskets



Post & Panel

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# Other Types of Levee Closure Systems



**Normal Low Flow**



**With Bulkheads in Place During Flood Event**

**Bulkheads for Gravity Flow Outlet Through Pump Station**

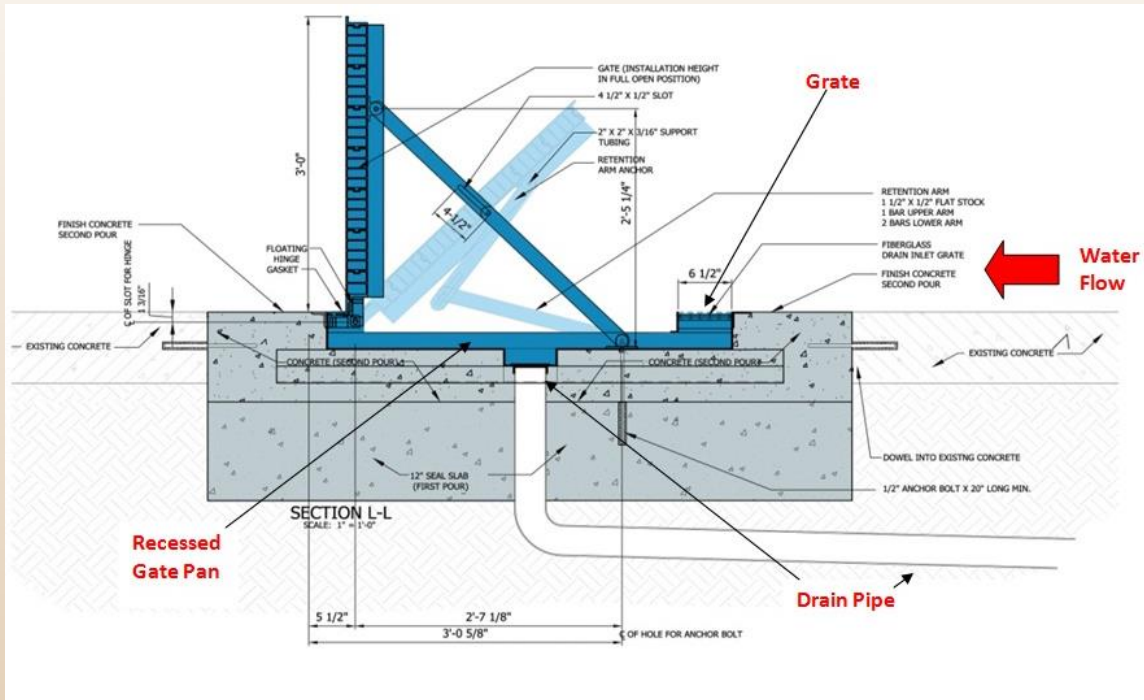
# Still Other Types of Levee Closure Systems



- “Demountable” Closure
- Assembly can take multiple days
- Requires dedicated team of knowledgeable craftsmen
- All components stored in dedicated vault.



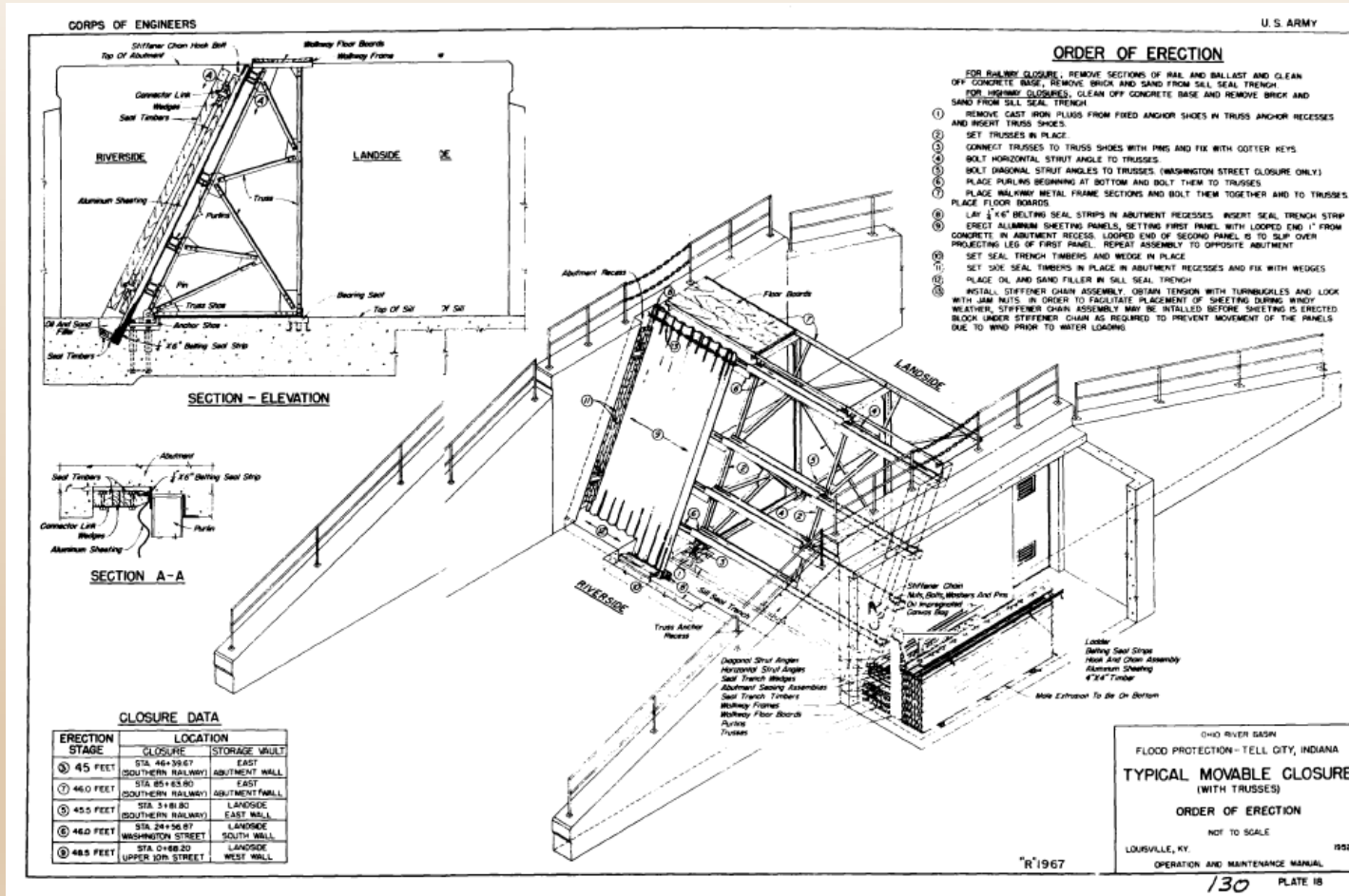
## Yet Another Type of Levee Closure System



- **Passive FloodBreak® closures are raised automatically**
- **Over 200 installations in the U.S.**
- **None in USACE inventory to date – all are privately owned or owned by municipalities.**



# Key Risk Factors - Stoplog & Post/Panel



Example of post & panel closure installation plan

Is there an approved plan for the placing the structure?

Many closures structures have a variety of parts with explicit installation instructions

Are the personnel setting the closure well-trained on installation procedures?

How long since the last time the closure was successfully set in place as part of training or active flood situation? Ideally within the last 5 years.

Is the general condition of all parts and superstructure in good operating condition?



# Key Risk Factors – Stoplog & Post/Panel



How securely are the closure parts stored? It is not uncommon for vandalism and theft to be a significant risk in some instances.



When is last time the parts were inventoried? Parts ideally should be marked as shown on plans and inventoried annually.

# Key Risk Factors for Moveable Gates



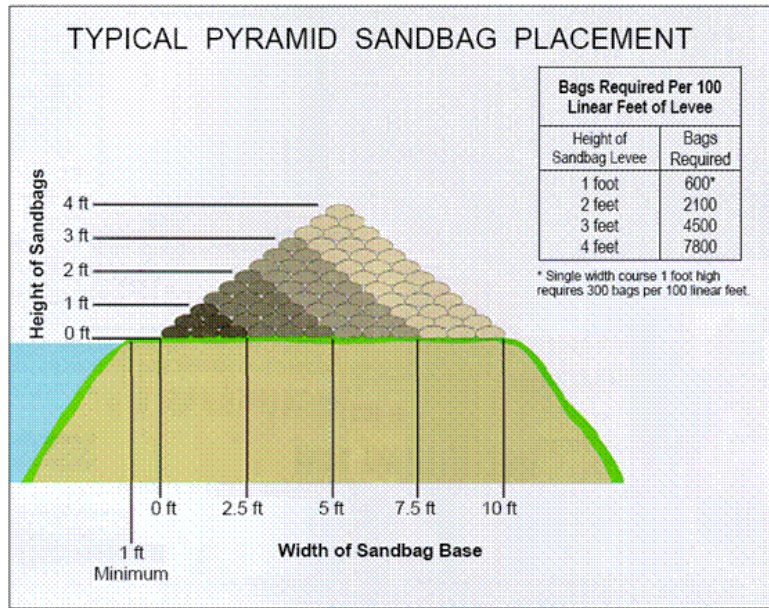
Assuming closure structure is in good operating condition, the biggest risk is likely ensuring the gate structure is closed and set in place.

In highly urbanized areas with many closure structures, this is not always a guarantee when individuals are ordered to evacuate.

In some cases, supporting equipment may be needed to set closure in place.



# Key Risk Factors – Sand Bag Closures



What is experience level in setting sandbag closure? They take a lot of time and manpower. Is there enough warning time to set sandbag closure given time requirements?

Placing sandbag closure properly requires enough base width to ensure a stable sandbag wall is built for select heights.

Many times they are placed by volunteer forces without any working knowledge of how they should be constructed.

Where are bags stored? How will they be obtained?



# Key Risk Factors – Soil Pile/Soil Baskets



Biggest risk factor relates to placement method with particular focus on the foundation. There have been noted failures where soil baskets have become unstable due to improperly prepared foundation.

Fairly easy way to quickly raise the damming surface, but less of an 'engineered' structure and typically built 'on the fly' without design considerations, etc.



# Types of Culvert Closures



FLAP GATES\*\*



SLUICE GATES WITH OR W/O  
GATE WELL FEATURE\*\*



VERTICAL SLIDE GATES



KNIFE GATES  
(UNCOMMON)



RUBBER DUCK  
BILLS (UNCOMMON)

# Key Risk Factors – Culvert Gates

- Biggest risk of causing interior flooding among all closure types due to frequency of exposure to river levels compared to other closure types.
- Debris being pulled into culvert and blocking the gate is a fairly common issue that has led to interior flooding.
- Size of pipe will restrict amount of water allowed to enter and when small enough could be blocked in an emergency
- Access can be an issue when there is a performance issue particularly when gate is located on river side of levee crest.





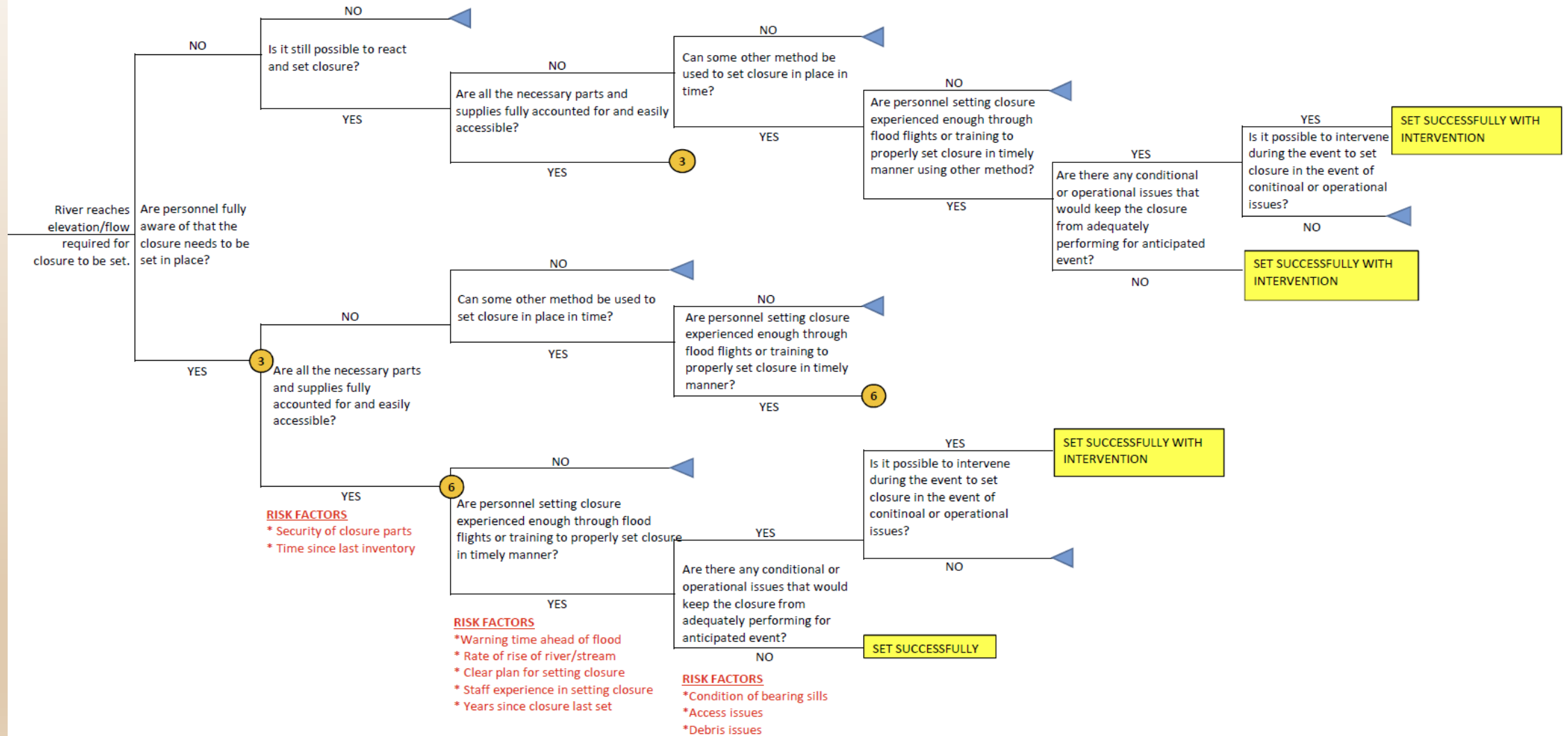
# Miscellaneous Issues – All Closure Types

Are there any 'Miscellaneous Issues' that could adversely impact the ability to successfully set the closure structure. An example is shown below where there is an ownership issue with the closure and the house owner fenced in the closure structure.



Other examples might include communication disruptions, lack of understanding of the system overtopping location, tie-in with other features, etc.

# Example Event Tree – Post & Panel





# Estimating Risks for Closure Systems

- Function of loading annual chance exceedance to reach level of closure is first step in estimating risk.
- Engineering analysis methods are available to estimate likelihood of failure given it is successfully set in place and hydraulically loaded; however, it is unlikely this is the driving risk.
- The ability to successfully set the closure prior to the flood arriving is the biggest risk and elicitation methods most likely would be used for estimating nodal probabilities.
- The ability to intervene successfully is possible and needs to be considered for some closure types.



# Key Takeaways – Closure Systems

- There are a variety of closure systems in use. Each has their own risk factors to consider.
- Many times the risk associated with successfully setting the closure in place ahead of the flood arrival is critical as it requires a knowledge of the system and a full accounting of all parts to be installed.
- Historical database of levee performance indicates many different instances where closures malfunctioned and led to interior flooding although the closure itself can help limit the amount of flow into the interior in many cases.
- Culvert gate closures are more problematic than other types because of their required frequency of use (they sit low on the levee prism), potential for debris to block closure, and are not easily accessible during periods of flooding.
- Elicitation based methods are likely best suited for estimating nodal probabilities for most closure system risk evaluations. Historic operations and frequency of inventory/closure setting can provide good references for estimating the risk.





# Questions, Comments, or Discussion

Thank you for your attention.

